

Cigeo, the Project for Geological Disposal Project of Radioactive Waste in France – 14014

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ABSTRACT

The Cigeo project is the natural progression of 15 years of research on the geological disposal of nuclear waste in France. Andra has taken all necessary measures to ensure that Cigeo can become operational in 2025. The Agency has also been reorganised in response to the new industrial challenges while also complying with all requirements regarding the safety and reversibility of geological disposal.

INTRODUCTION

France was one of the first countries to become aware of the need for establishing a responsible, proactive policy on the management of radioactive waste. In the case of the most highly radioactive waste, deep geological disposal is the only solution capable of ensuring its long-term safety while also reducing its effects upon future generations. The French Cigeo project is designed to continue operation for more than a century.

In passing the 1991 Bataille Act [1], the French Parliament placed France's nuclear policy on the path to finding long-term, safe solutions for disposing of radioactive waste and avoiding any burden on future generations with the radioactive waste we generate through our daily power use.

LANDMARKS

Each year, radioactive waste is generated in France primarily at the country's nuclear power plants and by its defence, industrial, healthcare and research sectors. A number of solutions already exist for the majority of this waste. In fact, 90% of the total volume of radioactive waste generated each year in France is disposed of in Andra's facilities [2]. Table 1 provides a breakdown of French radioactive waste production by categories, in terms of both volume and radioactivity level.

Table 1: breakdown of French radioactive waste, by volume and by radioactivity level

VOLUME OF WASTE ALREADY PRODUCED At end 2010		DISTRIBUTION OF VOLUME AND RADIOACTIVE LEVELS OF RADIOACTIVE WASTE At end 2010	
CATEGORIES	(Equivalent M ³ packaged)	Volume of waste as % of the grand total	Radioactivity level as %
HLW (High level waste)	2,700	0.2	96
LL-ILW (Long-lived intermediate- level waste)	40,000	3	4
LL-LLW (Long-lived low-level waste)	87,000	7	0.01
SL-LILW (Short-lived low and intermediate-level waste)	830,000	63	0.02
VLLW (Very low-level waste)	360,000	27	< 0.1
DSF* (Uncategorised waste)	3,600	-	-
GRAND TOTAL	1,320,000	-	-

The project to construct an industrial facility for the geological disposal of radioactive waste (in French, Centre Industriel de stockage Géologique, or Cigeo) has been designed to provide a lasting solution for safely disposing of France's most highly radioactive waste. Cigeo has been sized according to the production forecasts up to the end of the existing nuclear power plants fleet lifetime. Allowing for safety margins, Cigeo is designed to handle 10,000 m³ of vitrified high-level waste (HLW) and 100,000 m³ of long-lived intermediate-level waste (ILW-LL). HLW is exothermic, whereas ILW-LL only emits a low level of residual heat produced by the traces of spent fuel undissolved during the fuel's processing. The benchmark scenario, which was laid down in the French act passed in 2006, provides for the processing of spent fuel and the recycling of materials such as U and Pu. Within the framework of the French National Plan for the Management of Radioactive Materials and Waste (PNGMDR) [3], however, other options are also being studied, notably including the possibility of disposing of the spent fuel.

Cigeo has now entered its industrial design phase, under a prime contractor who has already managed the project for two years. The work packages comprising the Cigeo sub-systems were allocated at the end of 2013. All necessary measures have therefore been taken to enable Cigeo to progress towards the preparation of the industrial project.

As required by the French Planning Act of 2006 [4], a debate on the project has been organised by the French National Public Debate Commission, initially from 15 May to 15 October 2013. This mainly concerns the choice of deep geological disposal, the facility's location in the Meuse and Haute-Marne departments and Cigeo's risk management, with the objective of preparing the future legislation that will fix the reversibility conditions applicable to the disposal facility.

A DISPOSAL FACILITY PROVIDING VERY LONG-TERM PROTECTION

Some waste will remain hazardous for more than 100,000 years. The disposal of high-level long-lived waste in surface or near-surface facilities is impossible, as it cannot be guaranteed that the radioactivity can be contained over such lengths of time. Proven safety must be provided for 10,000 years, with an impact level that is to remain below 0.25 mSv per year. Furthermore, tangible proof that the impact level will continue to remain below 0.25 mSv per year for a million years must also be provided, although the radioactivity will have already greatly diminished after 10,000 years. In order to meet the safety requirements, Cigeo's waste disposal zone will be located at a depth of approximately 500 m in argillite that has been stable for 160 million years (Figure 1).

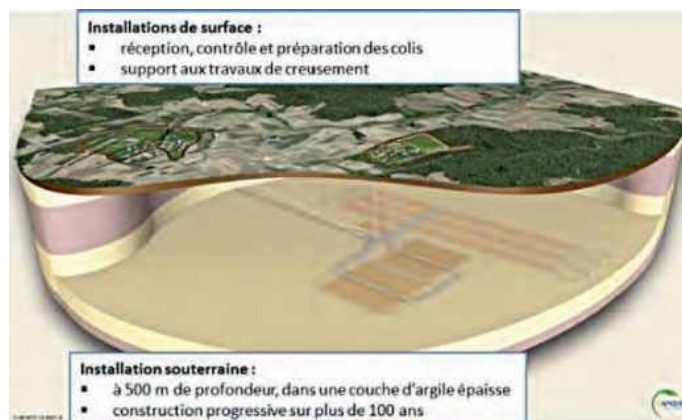


Fig. 1: Schematic diagram of Cigeo after 100 years in operation. ©Andra

The disposal zone will cover an area of 15 km², most of which will hold exothermic, high-level waste, whereas long-lived intermediate-level waste can be disposed of in compact form, in dedicated drifts. On the surface, a nuclear facility will be built for receiving the waste packages, inspecting them (Figure 2), preparing them for disposal and then transferring them down to the disposal zone by means of a drift inclined at a gradient of approximately 10-12%.

As shown in Table 1, this waste represents around 4% of the total volume of existing radioactive waste in France, and more than 99.9% of the total radioactivity. It is mainly generated in the processing of spent fuels from nuclear reactors. While awaiting disposal, the waste is stored dry in buildings on the La Hague, Marcoule and Cadarache sites.



Fig. 2: Inspecting a high-level waste package. © Andra

A CHOICE BASED ON MORE THAN TWENTY YEARS OF RESEARCH, AND INTERNATIONALLY SHARED

After fifteen years of research on partitioning and transmutation, deep geological disposal and long-term storage followed by their assessment and a public debate on the French national policy regarding the management of radioactive materials and waste, the French Parliament chose in 2006 [4] to implement deep geological disposal as the only solution capable of providing the long-term safety of the radioactive waste while also reducing its effects upon future generations. The results of the research conducted by CEA have shown that partitioning and transmutation would only be applicable to certain radionuclides contained in the waste (actinides), and that the fourth-generation nuclear reactors in which such a technique could be used would produce waste whose deep geological disposal would also be necessary for safety reasons. In any case, partitioning and transmutation could not be applied to waste already produced or currently in the existing nuclear power generation cycle.

Long-term storage of the waste (for approximately a century) does not provide a lasting solution, as this requires its sustained monitoring by society and its recovery by future generations.

PROGRESSIVE CONSTRUCTION BASED ON THE REQUIREMENTS

France's choice was reinforced by an EU Council Directive in 2011 [5], which states that deep geological disposal is currently the safest and most sustainable solution as the end point of the management of high-level waste. All countries that use nuclear energy have chosen deep geological disposal as a safe and sustainable means of managing their radioactive waste. France is one of the most advanced countries in the world, along with Sweden and Finland, which are currently reviewing applications for licences to build such facilities.

HUNDRED-YEAR OPERATION: A PROJECT FOR INSERTION IN THE RURAL COMMUNITY

If its construction is authorised, the Cigeo industrial facility for the geological disposal of radioactive waste will operate for more than 100 years and be expanded as needed. Cigeo is a vital industrial development project for the community, which is currently mainly rural. It is estimated that Cigeo will directly create between 1,300 and 2,300 jobs in its initial construction phase (2019-2025), followed by between 600 and 1,000 permanent jobs. A community development plan, which was created under the aegis of the Government, identifies the associated infrastructure, housing and training requirements, etc.

The Centre will consist of two surface facilities, located in the Meuse and Haute-Marne departments, and an underground facility in the clay layer, studied by Andra in its underground laboratory. The laboratory houses many experiments whose initial results have provided information for the various regulatory files, and which now house large-scale experiments and tests using demonstrators.

Once the disposal facility has been closed off, Cigeo's depth and design combined with its location inside impermeable clay within a stable geological environment will permanently protect the waste from human activities and surface natural phenomena.

The coexistence of excavation work and nuclear radioactivity at a depth of 500 metres is a key issue in the 100-year operational phase, notably from the fire risk management point of view.

PROJECT COST

For the entire operating life of a new nuclear reactor, the cost of radioactive waste disposal is approximately 1-2% of the total cost of electricity production. Estimating the disposal cost is nevertheless an important element in determining the financial reserves that EDF, Areva and CEA, the waste generators, will require.

Andra is therefore responsible for estimating all radioactive waste disposal costs for over 100 years. The estimated disposal cost will then be finalised and made public by the Government after taking into account the waste generators' comments and the opinion of the French Nuclear Safety Authority (NSA).

A FLEXIBLE DISPOSAL FACILITY

Cigeo is designed for the waste generated by existing nuclear facilities. Its flexibility enables it to adapt to potential energy policy changes.

Given the volume of existing waste to be disposed of (50% of the waste destined for Cigeo has already been generated), the impact of a change in France's energy policy would not affect Cigeo's operation until sometime around 2070. As a precautionary measure, however, the Government has asked Andra to check that the disposal concepts chosen for Cigeo provide for the possibility of spent fuel being disposed of directly if it is classified as waste one day.

A REVERSIBLE DISPOSAL FACILITY

In order to be able to adapt to any energy policy changes, the French Parliament has required that the waste disposal be reversible for at least 100 years. The technical arrangements proposed by Andra do not compromise the facility's safety and are industrially realistic. Figure 3 shows the disposal cells' basic design, with the waste packages, as well as the technical emplacement and removal arrangements used to handle the waste.

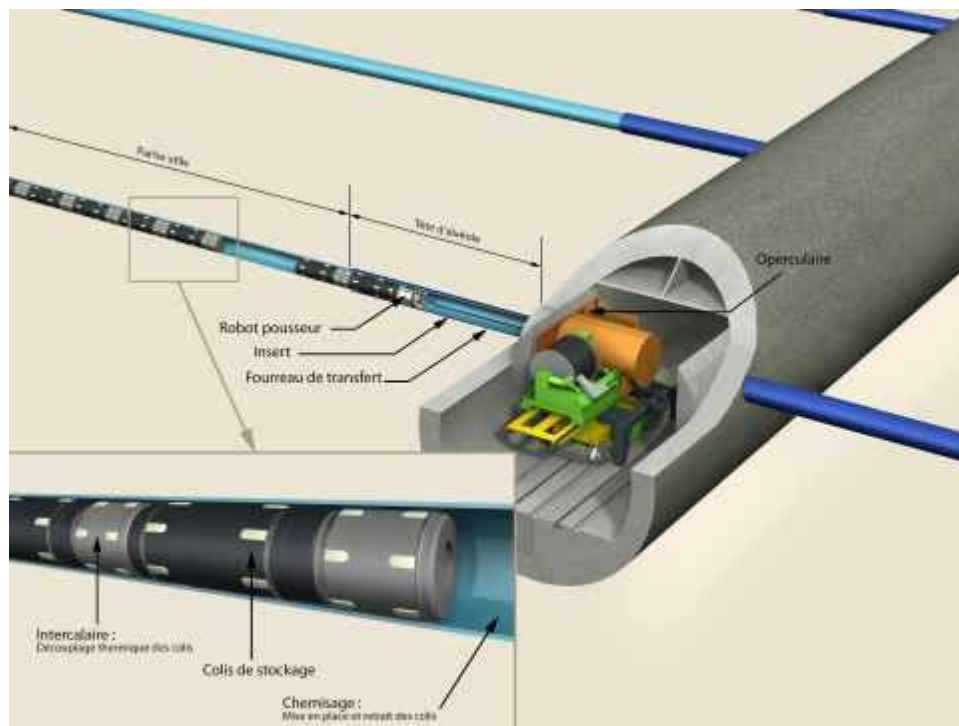


Fig. 3: Schematic diagram of an HLW package disposal cell © Andra

The proposed technical arrangements will enable Andra to decide the stages in which the disposal cells are closed off and, if appropriate, the packages are removed. The debate over the operating life of the nuclear power plants clearly shows that the social aspects must be integrated into the technical analysis.

Once Cigeo has begun operation, Andra proposes to organise regular meetings in which all of the project's stakeholders participate (review bodies, elected representatives, representatives of civil society, waste generators, etc.). These meetings will provide a forum for examining feedback and prospects regarding the Centre's operation, discussing the latest scientific and technical knowledge, and updating the reversibility conditions in accordance with the principles described by the OECD's Nuclear Energy Agency [6].

ASSESSMENT PROCESS

Reversibility has been one of the main topics of the public debate in 2013 [7], which was prerequisite to the construction license application being filed for Cigeo in 2015. This application will then be assessed over a period of several years. During this period, the project will be considered by the French Nuclear Safety Authority (NSA), the French National Assessment Board (CNE) set up by the French Parliament, the local authorities and the French Parliament. The Government will only grant the licence once a new act scheduled for 2016, laying down the disposal facility's reversibility conditions, is passed and a public inquiry is held, for the facility to begin operation around 2025.

THE PUBLIC DEBATE OF 2013

Under the terms of the Aarhus Convention, a public debate is mandatory prior to the construction of any large facility or infrastructure, as it provides a forum for discussing the project concerned and its impact upon the environment. France's National Public Debate Commission (CNDP), which is an independent body, is legally responsible for organising the public debate. Depending on the complexity or details of the project concerned, the CNDP may then decide to form a Special Public Debate Commission (CPDP), which it has done for Cigeo. The CPDP has conducted several months of preparatory work, which consisted in holding consultation meetings and informing the public and then defining how the debate, the means of dialogue and the public hearings are organised. The Cigeo project presentation document submitted for public debate was prepared by Andra.

The debate, which included online Q & A sessions and – especially – virtually weekly public meetings, was initially scheduled for 15 May to 15 October 2013. Following the first two public meetings, however, both of which the CPDP's chairman chose to interrupt to avoid violence following noisy opposition by a few participants, the debate procedure was changed. From September onwards, the debate has been organised into small groups in the villages, as well as online with direct sessions. It has also been decided to hold a citizens' conference, scheduled for the beginning of 2014. As the local press has agreed to publish the public's questions and the answers provided by the CPDP every Sunday with the backing of the main stakeholders, including Andra, a new means of dialogue has been created. Lastly, the CPDP has extended the public debate by two months as allowed by law.

It is interesting to note the collective disapproval of the attitude of a few opponents who, in demanding their democratic rights, have succeeded in preventing the public meetings from being held. The issue was not only that of the Cigeo debate, but much more than that: the principle of public debate itself. The local and national press, followed by the French Parliament via its Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST), and finally former Government ministers including two former Prime Ministers, have risen up against minority machinations preventing the fundamental democratic right to public debate.

The debate is therefore continuing in accordance with the new procedure fixed by the CPDP, and its conclusions and recommendations are expected in the first months of 2014.

CONCLUSION

Cigeo is a project that dates back 20 years, when the Meuse and Haute-Marne local authorities applied to host an underground laboratory. The 15 years of research required by the French law

of 1991 [1] have resulted in considerable advances. Not only has the Bure laboratory become a worldwide benchmark, but also its considerable high-value-added scientific production and high-value-added technological contributions are undeniable assets vis-à-vis the local population and its elected representatives.

Today, the industrial shift has taken place and the initial outlines have been presented in the public debate. Although the date may be revised depending on the recommendations, the deep geological disposal facility is scheduled to begin operation in 2025, as demanded by the French Planning Act of 2006 [4].

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